LINEAR TRACKING COLUMN MODULEWITH PEDAL ASSEMBLY

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This Application claims the benefit of United States Provisional Patent Application No. 60/473,787 filed on May 28, 2003, and United States Provisional Patent Application No. 60/444,297 filed on January 31, 2003.

FIELD OF THE INVENTION

[0002] The subject invention relates to a vehicle steering assembly having components movable in response to a crash condition.

BACKGROUND OF THE INVENTION

[0003] Adjustable steering column assemblies are well known in the art. Such assemblies typically include an energy-absorbing bracket or other support affixed to the body of a vehicle. Steering column components including, but not limited to a steering wheel and shaft are carried by the support. Should a collision occur in which a sufficiently large impact force is applied to the steering wheel, the steering column and wheel will collapse relative to the support and translate away from the driver of the vehicle.

[0004] Steering column and pedal assemblies exist which are designed to absorb forces other than those applied to the steering wheel of a vehicle. Such assemblies include those in which the foot pedals are mounted on the vehicle support structure independently of the mounting of the steering column, and where the pedals collapse under an applied collapse load in a crash event. An object of the present invention is to improve upon and simplify the manufacturing of collapsible column and pedal assemblies.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0005] The present invention provides a collapsible steering assembly including a steering mechanism and at least one foot pedal that is moveable in operation between a fully retracted position and a fully depressed position. A support structure connects the pedal or pedals to the steering mechanism to define a unitized module. The support structure supports the steering mechanism for collapsing movement in response to a predetermined collapse force on the steering mechanism. The support structure further supports the pedal or pedals for collapsing along a predetermined collapse path beyond the fully depressed position in response to application of another predetermined collapse force to the pedal or pedals.

[0006] Accordingly, the subject invention overcomes the limitations of the related art by providing a collapsible steering column assembly which utilizes guide rods to interconnect a steering assembly and pedal assembly with a single support structure to create a unitized module which may then be transported unit to an end user and installed as a single unit on a vehicle. The guide rods are capable of collective movement for permitting the steering assembly and pedal assembly to not only simultaneously translate relative to the support, but also independently move with respect to one another and to the support. The pedal assembly is mounted on the support structure in a manner that permits the pedal assembly to travel along a collapse path that is non-parallel to the longitudinal axis of the steering assembly.

[0007] The subject invention also includes a knee bolster interconnected by the guide rods to the support structure. The guide rods are distributed into two groups, with one group carrying the knee bolster and the other carrying the steering assembly. This permits independent movement of the knee bolster, pedal assembly and steering assembly relative to one another. The guides are also oriented to allow the knee bolster and steering assemblies to translate in directions other that those parallel to the longitudinal axis of the steering

assembly. In particular, the guides translate in directions corresponding to the typical trajectory paths of the upper torso and knees of a driver in a collision, which maximizes the energy absorbed by the assembly. The guides are also spaced to provide enhanced stability to the support, which minimizes the likelihood of accidental collapse of any one of the components of the assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0009] Figure 1 is a perspective view of a collapsible steering column assembly according to one embodiment of the present invention installed on a vehicle subassembly;

[0010] Figure 2 is a perspective view of a steering column assembly according to Figure 1 prior to installation on a vehicle subassembly and prior to a collision event;

[0011] Figure 3 is a perspective view of the steering column assembly shown in Figure 2 after a collision event, with the steering assembly and knee bolster in respective collapsed positions and the lever arm removed;

[0012] Figure 4 is a cross-sectional view of one of the first anvil-strap devices utilized in the steering column assembly shown in Figures 1 through 3;

[0013] Figure 5 is a cross-sectional view of a pivot assembly utilized in an alternative embodiment of the invention for pivotally connecting a bolster tube to the knee bolster;

[0014] Figure 6 is an exploded perspective view of the knee bolster, bolster tubes and selected components associated therewith of the embodiment of the invention shown in Figures 1 through 3;

[0015] Figure 7 is an exploded perspective view of the knee bolster and lower and upper blocks illustrating the manner in which the lower block is connected to the upper block;

[0016] Figure 8 is a partial perspective view of the upper block and pairs of high-force and low-force straps of one of the second anvil-strap devices utilized in the steering column assembly shown in Figures 1 through 3;

[0017] Figure 9 is a partial cross-sectional view of a pair of pyrotechnic devices and pyrotechnic pins utilized in the second anvil-strap device;

[0018] Figure 10 is an exploded perspective view of the support, rear bracket and other selected components of the collapsible steering column assembly shown in Figures 1 through 3;

[0019] Figure 11 is an exploded perspective view of a steering column assembly according to Figure 2 and utilizing an alternative pedal assembly; and

[0020] Figure 12 is an exploded perspective view of the steering column mounting bracket and selected components of the pedal assembly shown in Figure 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a collapsible steering assembly is generally shown at **20** in Figures 1 through 14. The assembly **20** includes a steering mechanism **22** and at least one and preferably two foot pedals shown generally at **24**. The pedals **24** are movable in operation between a fully retracted position "P_1" and a fully depressed position "P_2" for actuating an operating system in a vehicle **26**.

[0022] A support structure **28** connects the pedals **24** to the steering mechanism **22** to define a unitized module operant from any support structure of the vehicle to which the assembly will be mounted. The support structure **28** supports the steering mechanism **22** for collapsing movement in response to application of a predetermined collapse force to the steering mechanism **22**. The support structure **28** also supports each pedal **24** for collapsing along a predetermined collapse path **30** beyond the fully depressed position "P_2" in response to application of a predetermined collapse force **32** to the pedal **24**. Figure 3 shows the pedals **24** collapsed beyond the fully depressed position. Each pedal **24** is collapsible independently of the steering mechanism **22**. As is described in greater detail below, one pedal **24** is a brake pedal **34**. The other pedal **24** is a throttle pedal **36**.

[0023] The steering mechanism **22** has a longitudinal steering axis **38** that extends transversely to the predetermined collapse path **30**. A plurality of steering guide rods **40** are arranged about a common collapse axis **42** in non-parallel relationship to the steering axis **38**. The steering guide rods **40** interconnect the brake pedal **34** with the support structure **28** and guide movement of the brake pedal **34** along the predetermined collapse path **30** beyond the fully depressed position "P_2" in response to application of the predetermined collapse force to the brake pedal **34**. The steering guide rods **40** also interconnect the pedals **24** and the steering mechanism **22**.

[0024] The steering mechanism **22** includes a steering shaft **44** extending coaxially with the steering axis **38** between upper and lower ends **46** and **48**, respectively. An upper bearing housing **50** and a rake bracket **52** are coaxially disposed about the steering shaft **44** adjacent the upper end **46**. A lower bearing housing **54** is coaxially disposed about the steering shaft **44** adjacent the lower end **48**. An alternative rake bracket **56** having a curved outer edge is shown in Figure 11.

[0025] Although the steering mechanism **22** of the present invention is a steering column assembly, those skilled in the art will appreciate that the steering mechanism **22** used in the assembly **20** need not be limited to one utilizing a traditional, mechanical linkage column structure. The steering mechanism **22** may comprise, for example, an electric steer-by-wire system which may or may not include a mechanical shaft **44**.

[0026] Steering shear elements **58** interconnect the steering guide rods **40** and the support structure **28**. The steering shear elements **58** prevent the steering mechanism **22** from moving relative to the support structure **28**, and shear in response to application of the predetermined collapse force on the steering mechanism **22**, which in turn allows the steering guide rods **40** and the steering mechansim **22** to move relative to the support structure **28**.

[0027] The steering guide rods **40** are fixed relative to one another, which permits collective movement of the guide rods **40** relative to the support structure **28**. Although each of the steering guide rods **40** may have any suitable shape, each guide rod **40** of the embodiments of the present invention is straight and comprises a tube having a front end **60** and a rear end **62**. Although any number of steering guide rods, or tubes, **40** may be utilized and arranged in any suitable configuration relative to the support structure **28,** four of such steering tubes **40** are preferably spaced from one another in a quadrangle.

[0028] The support structure **28** includes a front bracket **64** that interconnects the front ends **60** of the steering tubes **40**. A rear bracket **66** supports the rear ends **62** of the steering tubes **40** and the steering mechanism **22**. The front and rear brackets **64** and **66** are spaced on opposite sides of an intermediate bracket **68**. The rear ends **62** of the steering tubes **40** extend through the rear bracket **66**.

[0029] A second plurality of steering shear elements **58** interconnects the rear bracket **66** and the steering tubes **40**. The steering shear elements **58** normally prevent movement of

the steering tubes **40** relative to the rear bracket **66**, but shear in response to the predetermined force for allowing the steering tubes **40** to move through the rear bracket **66**.

[0030] The assembly **20** also includes a knee bolster **70** coupled to the support structure **28**. A plurality of bolster guide rods **72** are arranged about a second collapse axis **74** and interconnect the intermediate bracket **68** and said knee bolster **70.** The bolster guide rods **72** support the knee bolster **70** for axial movement along the second collapse axis **74** in response to application of a second predetermined collapse force to the knee bolster **70**. A plurality of bolster shear elements **76** interconnect the bolster guide rods **72** and the intermediate bracket **68**. The intermediate bracket **68** supports the bolster guide rods **70** in fixed relationship to one another. The shear elements **76** prevent movement of the knee bolster **70** relative to the intermediate bracket **68** and shear in response to application of the second predetermined collapse force to the knee bolster **70**. This allows the bolster guide rods **72** and the knee bolster **70** to move relative to the intermediate bracket **68**.

[0031] While each of the bolster guide rods **72** may have any suitable shape, each guide rod **72** is a straight tube that has a front end **78** and a rear end **80**. Any number of bolster guide rods, or tubes, **72** may be utilized and arranged in any suitable configuration relative to the support structure **28.** The assembly **20** includes four of the bolster tubes **72**. The tubes **72** are spaced from one another in a quadrangle. The knee bolster **70** is connected to the front ends **78** of the bolster tubes **72,** and the rear bracket **66** supports the rear ends **80,** which in turns spaces the knee bolster **70** and the rear bracket **66** from and on opposite sides of the intermediate bracket **68**.

[0032] While any appropriate shearable device may be used, the steering shear elements **58** and bolster shear elements **76** of the present invention preferably comprise bushings. Each bushing surrounds one of the tubes **40** or **72** and engages one of either the

intermediate bracket **68** or the rear bracket **66**. Each bushing also has a detent or other feature which maintains the tube **40** or **72** in a fixed position relative to the intermediate bracket **68** or rear bracket **66** during normal operation. The detents or other features on the bushings maintaining the linkage between the intermediate bracket **68** or the rear bracket **66** and the respective tubes **40** or **72** will be broken, or "shear", upon application of a sufficient collapse force to the steering mechanism **22** or the knee bolster **70**. This overcomes the holding force on the tubes **40** or **72** and releases the tubes **40** or **72** for movement relative to the intermediate bracket 68 or rear bracket **66**.

[0033] The front bracket **64** includes a central opening **82** and a peripheral edge **84** from which a collar **86** extends. A collar **86** having an alternative shape is shown in Figure 11. The upper end **46** of the steering shaft **44**, the upper bearing housing **50**, and the rake bracket **52** extend through the opening **82**. The lower end **48** of the steering shaft **44** extends beyond the rear bracket **66**, whereby the front bracket **64**, intermediate bracket **68** and rear bracket **66** are spaced along the steering shaft **44** between the upper and lower ends **46** and **48**.

[0034] A rake assembly is generally shown at **88**. The rake assembly **88** interconnects the rake bracket **52** with the front bracket **64** and permits selective pivotal movement of the steering shaft **44** relative to the intermediate bracket **68** and front bracket **64**. The rake assembly **88** includes an adjustment mechanism **90** disposed against the front bracket **64** and engaging the steering shaft **44** for moving the steering shaft **44** relative to the opening **82**. A spring **92** interconnects tabs **94** extending from the rake bracket **52** and front bracket **64** for supporting the steering shaft **44** at a preselected rake angle (α) relative to the steering tubes **40**. The collar **86** has a slot **96** through which a complementary nut and bolt

assembly **98** extends for interconnecting the adjustment mechanism **90** with the steering shaft **44** and maintaining the shaft **44** at the preselected rake angle (α).

[0035] The rear bracket **66** includes at least one and preferably two connectors **100** for attachment to the vehicle **26**. The intermediate bracket **68** likewise includes at least one and preferably two connectors **100** for attachment to the vehicle **26**. Each connector **100** has a hole **102** extending therethrough for receiving a complementary bolt (not shown) to permit attachment to the vehicle **26**. As is best shown in Figure 7, the intermediate bracket **68** includes an upper block **104** having bores **106** therethrough. The steering tubes **40** extend through the bores **106**. The intermediate bracket **68** also includes a lower block **108** having bores **110** therethrough. The bolster tubes **72** extend through the bores **110** in the lower block **108**.

[0036] The steering tubes **40** of the assembly **20** include an upper pair and a lower pair. A steering mechanism support bracket **112** interconnects the lower pair and supports the steering mechanism **22**. The steering mechanism support bracket **112** has spaced arms **114** with bores **116** extending therethrough. The lower bearing housing **54** extends between the arms **106**. Pivot pins **118** are received within the bores **116** for pivotally connecting the lower bearing housing **54** to the steering mechanism support bracket **112**, which permits pivotal movement of the steering mechanism **22** relative to the steering mechanism support bracket **112**.

[0037] The assembly **20** of the present invention also includes at least one and preferably two beams **120** which interconnect the upper block **104** and the rear bracket **66** to prevent relative movement therebetween. The upper block **104** and rear bracket **66** include slots **122**. The beams **120** have opposed ends **124** that are received within the slots **122**.

[0038] Referring specifically to Figure 7, the manner in which the lower block **108** is connected to the upper block **104** is shown. The lower block **108** includes spaced bracket segments **126** through which the bores **110** extend. The bracket segments **126** are interconnected by a web **130** having threaded bores **132** extending therethrough. The upper block **104** includes complementary threaded bores **134**, which are aligned with the bores **132**. Threaded fasteners **136** are received within respective pairs of the aligned bores **132** and **134** for connecting the lower block **108** to the upper block **104**.

[0039] The bolster tubes **72** of the assembly **20** are disposed in at least one pair on either side of the steering tubes **40**. The bolster tubes **72** are also disposed transversely to the steering tubes **40**. Two pairs of bolster tubes **72** are preferred, and each pair extends through the bores **110** in a selected one of the bracket segments **126**.

[0040] Disposing the bolster tubes **72** outside the steering tubes **40** permits the knee bolster **70** to collapse without interfering with or otherwise initiating a simultaneous or subsequent collapse of the steering tubes **40** and steering mechanism **22**. Positioning the bolster tubes **72** at a transverse angle to the steering tubes **40** orients the stroke path of the knee bolster **70** at an angle complementary to the normal trajectory of the knees of a vehicle operator or a passenger as the knees impact and simultaneously translate with the bolster **70** along the second collapse axis **74** in response to application of the second predetermined force on the bolster **70**.

[0041] One of two connective clamps **138** interconnects the rear ends **80** of each pair of bolster tubes **72**. The knee bolster **70** is supported by the front ends **78** of both pairs of bolster tubes **72**. Referring specifically to Figure 6, an annular ridge **140** on each of the front ends **78** is disposed in engagement with one of a plurality of annular rims **142** disposed on the bolster **70**.

[0042] As is shown in Figure 5, the front end **78** of each bolster tube **72** may alternatively be connected to the bolster **70** using one of a plurality of pivot assemblies **144**. Each pivot assembly **144** includes a collar **146** defining a concave pivot surface **148**. A shank **150** extends from the end **78** to an end sphere **152**. The sphere **152** is captured within the collar **146** and pivots relative to the surface **148**.

[0043] The knee bolster **26** is preferably fabricated from a deformable material such as metal and, as such, is deformable upon impact with the knees of a vehicle operator. The pivot assemblies **144** accommodate the deformation and bending forces imparted to the bolster **70** during such an impact by pivoting to allow the bolster **70** to bend relative to the tubes **72** without imparting a bending moment to the tubes **72**. The forces normally applied to the bolster **70** are instead applied in the axial direction of the tubes **72**.

[0044] Each clamp **138** extends between opposed cylindrical ends **154** having openings **156** within which the rear ends **80** are received. As is shown in Figure 6, the clamp **138** includes holes **160** adjacent each end **154**. Complementary fasteners **162** are received within the holes **160** for securing the adjacent cylindrical end **154** about the rear end **158**.

[0045] Although the knee bolster **70** is a single panel, the bolster **70** may alternatively be bifurcated to form a panel having left and right sections capable of independent movement relative to one another. The bolster **70** and components associated therewith may alternatively be adapted for use on the passenger side of the vehicle **26** or in any other passenger seating area within the vehicle **26**.

[0046] The assembly **20** also includes an energy absorber system **164** for absorbing movement of the steering mechanism **22** and pedals **24** respectively relative to the intermediate bracket **68**. The energy absorber system **164** of the assembly **20** also includes at least one and preferably two first anvil-strap devices generally shown at **166**. Each anvil-

strap device **166** interconnects a selected one of the clamps **138** with the lower block **108**. The anvil-strap devices **166** absorb energy upon movement of the bolster tubes **72** through the lower block **108** in response to the second predetermined collapse force.

[0047] Referring again to Figure 6, each anvil-strap device **166** includes a housing **168** disposed against one of the bracket segments **126**. Each bracket segment **126** has a central opening **170** interposed between spaced holes **172**. The housing **168** includes spaced connectors **174** which are received within the holes **172** for securing the housing **168** against the bracket segment **126**.

[0048] As is shown in Figure 4, an anvil block **176** has at least one and preferably two oppositely arranged anvils **178** and **180** disposed within the housing **168**. The anvils **178** and **180** are spaced from one another in one of two preselected positions to define one of two tortuous pathways **182** and **184**. A plastically deformable strap **186** having opposed ends **188** extends through the housing **168** along the first tortuous pathway **182** in frictional and bending engagement with the anvils **178** and **180**. One end **188** is secured to the clamp **138** by a nut and bolt assembly **164**. This permits the strap **186** to be pulled through the housing **168** along the first pathway **182** and simultaneously drawn against the anvils **178** and **180** for absorbing a controlled amount of energy as the bolster tubes **72** move relative to the lower block **108**.

[0049] The anvil-strap device **166** also includes a pyrotechnic assembly **190** for selectively controlling the amount of energy absorbed by the strap **186**. The pyrotechnic assembly **190** is carried by the housing **168** and communicates with an external control system **192**. The control system **192** functions to position the anvil **178** in a selected one of the pathways **182, 184** dependent upon one or more variable conditions existing prior to or during the crash condition.

[0050] Each pyrotechnic assembly **190** includes at least one explosive pin **194** that extends through the anvil **178**. A pyrotechnic actuator **196** is carried by the housing **168** and communicates with the pin **194**. The actuator **196** is selectively actuated by the control system **192** to cause the pin **194** to explode or otherwise be effectively removed from the anvil **178**. This permits lateral movement of the anvil **178** and creates the second tortuous pathway **184**.

[0051] Although the anvil-strap devices **166** of the assembly **20** are variable energy absorbing systems that utilize S-straps, one skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, pyrotechnic or other actuating devices, or a combination thereof.

[0052] The energy absorber system **164** of the assembly **20** also includes a second anvil-strap device, which is generally shown at **198** in Figure 1. The second anvil-strap device **198** interconnects the steering tubes **40** and upper block **104**. As is shown in Figure 2, the second anvil-strap device **198** includes a release bracket **200**. The release bracket **200** has bores therethrough and is disposed in engagement with the intermediate bracket **68** in the absence of the predetermined collapse force of the steering mechanism **22**. The steering tubes **40** extend through the bores and are carried by the release bracket **200** in fixed relation to one another. Refering now to Figure 8, at least one, or as disclosed, two pairs of plastically-deformable straps **204** with holes **206** therethrough are disposed in frictional engagement with respective pairs of first and second anvils **208** and **210**. The straps **204** interconnect the release bracket **200** with the intermediate bracket **68**. Each pair **204** includes a high-force strap **212** and a low-force strap **214** extending in parallel relation to one another from the release bracket **200**. As is shown in Figures 2 and 3, retaining pins **218** are disposed

within the release bracket **220**. Each pin **218** extends through one of the holes **206** and interconnects the associated strap **212** or **214** with the release bracket **200**. The pins **218** may alternatively be disposed within the upper block **104** for securing the straps **212** and **214** with the upper block **104** (not shown).

[0053] Like the first anvil-strap devices **166**, the second anvil-strap devices **198** are variable energy absorbing systems. However, the second anvil-strap devices **198** utilize pairs of S-straps having variable widths. One skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, pyrotechnic or other actuating devices, or a combination thereof.

[0054] A hinge assembly **220** extends from the release bracket **200**. The hinge assembly **220** may be used for attaching an optional display screen or other control device (not shown) to the assembly **20**.

[0055] Referring specifically to Figure 9, the second anvil strap device **198** also includes actuating devices **222**, which are disposed upon threaded bosses **224** that extend from the release bracket **200**. Each device **222** engages one of the pins **194** and selectively discharges for actuating movement of the pin **194** to a discharged position. This alters the frictional force generated by the strap **212** or **214** associated with the pin **194** as the strap **212** or **214** moves across the anvils **208** and **210** shown in Figure 8. Each pair of anvils **208** and **210** displaces a portion of the pair of straps **212** and **214** associated therewith and imposes a reaction force thereon to absorb energy as the straps **212** and **214** move past the anvils **208** and **210**. The anvil-strap device 198 is shown in Figure 3 after discharge of the devices **222** and following collapse of the steering assembly **22**.

[0056] Although any suitable actuating device may be utilized, each actuating device **222** is preferably an electrically activated pyrotechnic device. A control system such as that which is schematically depicted at **192** in Figure 4 is operatively connected to the devices **222**, monitors and detects variable components affected by the crash condition, determines the amount of energy to be absorbed, and transmits a signal corresponding to that amount to the actuating devices **222**, which in turn actuates or more of the devices **222**. For example, during a crash condition in which a large predetermined force is applied to the assembly **20**, none of the actuating devices **222** will be discharged in order to maximize the frictional forces between the pairs of straps **204** and the anvils **208** and **210**, which in turn maximizes the amount of energy absorbed. The actuating devices **222** will initiate release of the low-force straps **214** in response to a moderate predetermined force on the assembly **20**. The actuating devices **222** will respond to a low predetermined force on the assembly **20** by initiating release of the high-force straps **212**.

[0057] The assembly **20** may also use an alternative energy absorbing device, which is generally shown at **224** in Figures 10 and 11. The device **224** includes a single pair of high-force straps **226**. A release bracket **228** releasably engages the intermediate bracket **68**. The release bracket **228** includes bores **230** through which the steering tubes **40** extend in fixed relation to one another, and opposed sides **232** from which shear tabs **234** extend. A pair of pyrotechnic bosses **236** are disposed between the tabs **234** and bores **230**. The release bracket **228** also has a pair of elongate chambers **238** extending therethrough in communication with the bosses **236**.

[0058] The intermediate bracket **68** includes notches **238** in which the tabs **234** are disposed. Shear pins **239** interconnect each tab **234** and notch **238** for shearing in response to the predetermined collapse force to release the release bracket **228** from the intermediate

bracket **68**. The intermediate bracket **68** also has a slot **240** intermediate the bores **106**. As is shown in Figure 10, the strap guide **242** is disposed within the slot **240**. Pyrotechnic pins **244** are disposed within the notches **238** and connect the straps **226** to the release bracket **228**. The straps **226** extend from the pins **244** through the strap guide **242**. Actuation devices **246** identical to the actuation devices **222** are disposed within the bosses **236** and are operatively connected to a control system like the control system **192** shown in Figure 4. The pins **244** are selectively actuated by the actuation devices **246** to selectively control the rate of energy absorption by the straps **226** as the release bracket **228** moves away from the intermediate bracket **68**.

[0059] Referring again to Figures 2 and 3, the assembly **20** also includes a pedal assembly, which is generally shown at **248**. The pedal assembly **248** carries the pedals **24** or, as disclosed, the brake pedal **34** and throttle pedal **36**. The pedal assembly **248** is also disposed against the steering guide rods, or tubes, **40** for movement relative the support structure **12** in response to application of the predetermined collapse force to the steering mechanism **22**. Specifically, the pedal assembly **248** is pivotally connected to the rear bracket **66** for pivotal movement in response to movement of the steering tubes **40** relative thereto.

[0060] The pedal assembly **248** is an adjustable pedal assembly. A mounting assembly **250** carries the pedals **24** and a hinge assembly **252** interconnects the mounting assembly **250** and the support structure **12** for permitting pivotal movement of the pedals **24** relative to the support structure **12**. In particular, the hinge assembly **252** interconnects the mounting assembly **250** to the rear bracket **66**.

[0061] The brake pedal **36** is part of a brake assembly **254**. The brake assembly **254** includes a first bracket **256** that interconnects the brake pedal **34** and the mounting assembly

250. The first bracket **256** includes spaced slots **258**. Adjustment fasteners **260** adjustably mount the brake pedal **34** in the slots **258** for permitting movement of the brake pedal **34** relative to the first bracket **256**.

[0062] The throttle pedal **36** is part of a throttle assembly **262**. A second bracket **264** having spaced slots **266** interconnects the throttle pedal **36** and the mounting assembly **250**. Adjustment fasteners **268** adjustably mount the throttle pedal **36** in the slots **266** for adjusting the throttle pedal **36** relative to the second bracket **264**.

[0063] The hinge assembly **252** features a bifurcated bracket **270** that carries the mounting assembly **250**. The bifurcated bracket **270** has spaced openings **272** through which the rear ends **62** of two of the steering tubes **40** extend. A joint **274** is interposed between the openings **272** and extends between two nut and bolt assemblies **276**. A hinge **278** is pivotally connects the bifurcated bracket **270** to the rear bracket **66**, which permits pivotal movement of the mounting assembly **250** relative to the rear bracket **66**.

[0064] Rather than utilizing the mounting assembly **250** and hinge assembly **252**, the pedal assembly **248** may alternatively include a mounting assembly **280** and hinge assembly **282** such as those shown in Figures 10 and 11. In contrast to the mounting assembly **250**, the mounting assembly **280** includes a U-shaped plate **284** having at least one nut and bolt assembly **286** extending therethrough for securing the brake and throttle assemblies **254** and **262** to the plate **284**. An intermediate bracket **288** is disposed against the plate **284** and has holes **290** extending therethrough.

[0065] As is shown in Figures 11 and 12, the hinge assembly **282** includes a bracket **292** with spaced openings **294** through which the rear ends of two of the steering tubes **40** extend. The bracket **292** also has holes **296** aligned with the holes **290**. A threaded bolt **298** extends through each pair of the holes **290, 296** for securing the intermediate bracket **288** to

the bracket **292**. A hinge device **300** connected together by a complementary hinge pin **302** interconnects the bracket **292** and rear bracket **66** together for permitting pivotal movement of the pedal assembly **248** relative to the rear bracket **66**.

[0066] Referring now to Figures 12 and 13, the energy absorber system **164** also includes a shear strap mechanism **304** interconnecting the mounting assembly **280** and the rear bracket **66**. The shear strap mechanism **304** includes a pyrotechnic housing **306** disposed between the openings **294** of the bracket **292**. An actuating device **308** and a pedal shear pin **310** are disposed within the housing **306**. The pedal shear pin **310** is held in position by a shear pin retaining clip **314**. The rear bracket **66** includes a slot **316**. A strap guide **318** is disposed within the slot **316**. A plastically deformable strap **320** extends through the strap guide **318**. The strap **320** has holes **322** therethrough. Energy-absorbing tapping screws **324** extend through the holes **322** and connect the strap **320** to the bracket **292** and rear bracket **66**.

[0067] Although any suitable actuating device may be utilized, the actuating device **308** preferably comprises a gas generating pyrotechnic device. A control system such as that which is schematically depicted at **192** in Figure 4 is operatively connected to the device **308**. The control system monitors and detects variable components affected by the crash condition, determines the amount of energy to be absorbed, and transmits a signal corresponding to that amount to the actuating device **308**, which in turn actuates the device **308**. Furthermore, although a single plastically-deformable strap **320** is used in combination with a strap guide **318** to absorb energy, one skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, or a combination thereof.

[0068] The strap **320** maintains the bracket **292** in a stationary position relative to the rear bracket **66** in the absence of the predetermined collapse force **23** or **32**. However, upon application of the predetermined collapse force on the steering mechanism **22** or the pedals **24**, respectively, the actuating device **308** will "fire" or otherwise actuate and apply a downwardly directed force on the shear pin **310**. This causes the retaining clip **314** to loosen, which in turn releases the shear pin **310**. The pin **310** strikes and cuts the shear strap **320** apart, which frees the bracket **292** and permits pivotal movement of the pedal assembly **248** relative to the rear bracket **66**. The strap **320** is pulled through the strap guide **318** and absorbs energy as the freed assembly **248** pivots relative to the rear bracket **66**.

[0069] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.